

## MSDS 413, Summer 2019, Assignment 9 Multivariate Volatility Models (TS9)

### Introduction

The daily returns of Microsoft (msft) stock from January 1961 to December 2013. The data are available from CRSP and in the file d-msft3dx0113.txt Obtain the log return series of BA stock.

The following list defines the variables:

- PERMNO: price end of period
- date: year month day (monthly data)
- msft: monthly returns
- vwretd: unused for this assignment
- ewretd: unused for this assignment
- sprtrn: S&P monthly returns

Your objective is to explore the time series behavior of these data sets including EDA, modeling, model diagnostics, and interpretation.

### Procedure

The following steps are necessary to complete this assignment. Address each and every part and ensure that you cover all the details specified in the questions. Be sure to use all your analytical skills.

1. **Closing prices** (4 points) Use the daily adjusted closing prices on Microsoft and the S&P 500 over the period 2000-01-03 to 2012-04-10 to compute the continuously compounded returns.
  - 1.1. First, estimate an ARCH(5) model for each series. What is the sum of the ARCH coefficients? What does the sum tell you?
  - 1.2. Next, estimate a GARCH(1,1) model for each series. What is the sum of the GARCH coefficients? Interpret and compare with the ARCH sum.
  - 1.3. Using a 20-day moving window, compute and plot rolling covariances and correlations. Briefly comment on what you see.
  - 1.4. Let  $r_t = (r_{MSFT}, r_{GSPC}, t)^T$ . Using the `dccfit()` function from the `rmgarch` package, estimate the normal-DCC(1,1) model. Briefly comment on the estimated coefficients and the fit of the model.
  - 1.5. Plot the estimated in-sample conditional covariances and correlations of the DCC model. Compare with the EWMA and rolling estimates.

- 1.6. Using the Estimated DCC(1,1) model, compute (using **dccforecast()** function) and plot the first 100  $h$ -step ahead forecasts of conditional covariance and correlation.
2. **Report** (3.5 points) Write an executive summary of your Microsoft and S&P analysis.

## Deliverables

See Section Submission Directions below. The assignment deliverables, each in pdf format, are as follows:

- *Only if requested by instructor*
  - The program or script
  - Logs
  - Outputs
- Mandatory  
Data analysis write-up: no programs, logs, or just code outputs.

The data analysis must follow and use the item numbering of each assignment, i.e., use the numbers, say, 1 - 5, with the sub-lettering if used. These deliverables are provided according to the instructions in the Submission Directions section below.

## Submission Directions

### Title Page

Include a title page with your name and the assignment designation. Leave room for instructor comments.

### File Names

The assignment write-up file shall be submitted to Canvas according to the schedule in the syllabus using the item (1) naming convention below. The naming convention is case sensitive. Use letters and numbers as given. **The file name parts have no spaces or other separator characters.** TS9Lastname.pdf (submit via Canvas)

The parts are the assignment code, TS9; your lastname with only the first letter capitalized; a period, and lastly, the extension “pdf”. Generically,

TS9Lastname.pdf

For example: Suppose your name is Student McStats. Your filename then is:

TS9Mcstats.pdf

The analysis write-up file must be submitted for grading. Each write-up requires a title page for instructor comments. The analysis may use either R or any other statistics package you wish, or if you use more than one package, you must use the germane tables, plots, etc., in a single report. If you use more than one package, differences and similarities should be indicated.

**email: [jamie.riggs@northwestern.edu](mailto:jamie.riggs@northwestern.edu)**

Email *ONLY IF REQUESTED* the program (script), log and output as separate pdf files. The R log and output may be combined. The file names shall be as follows:

- The program or script file names
  - TS9LastnameRprog.pdf
- The log file names
  - TS9LastnameRlog.pdf